PERFORMANCE OF STONE MASTIC ASPHALT INCORPORATING KENAF FIBRE

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Batu Mastic Asfalt (SMA) mengandungi jumlah agregat yang tinggi sehingga ia mempunyai interlocking yang lebih baik disebabkan oleh batu itu untuk menyentuh batu tetapi mudah tersentuh untuk mengikat masalah. Oleh itu, matlamat kajian ini adalah untuk menggunakan peratusan Kenaf yang berlainan dalam Asfalt Batu Mastic untuk mengatasi isu-isu yang berkaitan dengan Asfalt Batu Mastic seperti rutting dan retak disebabkan oleh jumlah trafik yang tinggi dan cuaca yang melampau. Antara ujian yang terlibat ialah LA Abrasion, Kestabilan Marshall, Modulus Berkekalan, dan Creep Dynamic. Dari hasilnya, ia menunjukkan bahawa penambahan serat 0.2% menyumbang kepada lelasan nilai terendah. Walaupun, serat 0.2% menghasilkan kepadatan tertinggi. Ia dapat dilihat 0.6% daripada serat Kenaf menghasilkan nilai modulus yang paling berdaya tahan. Creep dinamik juga menunjukkan nilai yang signifikan dalam penambahan 0.2%. Oleh itu, dapat disimpulkan bahwa keberadaan serat mampu meningkatkan prestasi SMA yang jelas misalnya, ketumpatannya. Untuk kajian masa depan, disarankan untuk menganalisis prestasi SMA dari segi rintangan rayap, Kestabilan Marshall, dan rintangan rutting SMA dengan kewujudan serat Kenaf untuk membuktikan kebolehpercayaannya dalam pelbagai aplikasi dalam campuran asfalt.

ABSTRACT

Stone Mastic Asphalt (SMA) contains a high amount of aggregate making it has a better interlocking due to the stone to stone contact but it is susceptible to binder drain down problems. Thus, the aim of this study is to utilize different percentages of Kenaf fibre in Stone Mastic Asphalt to overcome issues related to Stone Mastic Asphalt such as rutting and cracking due to high traffic volumes and extreme weather. Among the test involved were LA Abrasion, Marshall Stability, Resilient Modulus, and Dynamic Creep. From the results, it shows that the addition of 0.2% fibre contributes to lowest value of abrasion. While, 0.2% fibre produce the highest density. It could be seen 0.6% of Kenaf fibre producing highest value of resilient modulus. Dynamic creep also shows a significant value in 0.2% addition. Thus, it can be concluded that the existence of fibre is capable in enhancing the performance of SMA which is evident for instance, the density. For future study, it is recommended to analyses the performance of SMA in terms of creep resistance, Marshall Stability, and rutting resistance of SMA with the existence of Kenaf fibre in order to prove its reliability in various applications in asphaltic mixture.

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LIST OF SYMBOLS

C	Celcius
MPa	MegaPascal
N/mm2	Newton per millimetres square
N	Newton
Kg	Kilogram
g	gram
Mm	Millimetres
cm	centimeters

LIST OF ABBREVIATIONS

SMA	Stone Mastic Asphalt
KF	Kenaf Fibre
REV	Number of Revolution
NAPA	National Asphalt Pavement Association
PA	Porous Asphalt
HMA	Hot Mix Asphalt
PWD	Public Work Department
JKR	Jabatan Kerja Raya
AIV	Aggregate Impact Value
ACV	Aggregate Crushing Value
ASTM	American Section of the International Association for Testing Material
BS	British Standard
NF	Natural fibre

CHAPTER 1

INTRODUCTION

1.1 Introduction

The National Asphalt Pavement Association (NAPA) states that Stone Mastic Asphalt (SMA), an asphalt paving mixture, was born in Germany in the 1970s to provide maximum rutting resistance caused by stubborn tyres on European roads, leading to the development of SMA by Strabag, a large German construction company. When studded tyres were no longer permitted, it was found that SMA provided long-lasting pavements that showed such high rutting resistance due to heavy truck traffic and proved extremely effective in wear resistance. Because of their excellent permanent resistance to deformation, several countries are using SMA in their mixes, according to Sara et al.

Because of its production process, SMA ended up costing more than regular dense-graded mixes, so it is recommended to be used in high-volume interstate highways to benefit from its durability and strength. Due to the impressive friction capabilities with tires, it will also increase driver safety; it will also minimize tire noise and reduce reflective cracking. Stone matrix asphalt (SMA) is a gap-graded mix with a high coarse aggregate concentration. They are held together as stabilizers in a thick asphalt film by a rich matrix of mineral filler, fiber or polymer.

They are held together as stabilizers in a thick asphalt film by a rich matrix of mineral filler, fiber or polymer. Rich mortar binder gives the durability. There is better stone-to-stone contact and stronger interlocking due to the high content of coarse aggregate which serves as the structural basis of SMA. Drain down is a major concern related to SMA Mix. Other reasons for introducing new modifiers in asphalt technology are due to technological advancements, fresh material production and advances in asphalt material science (Taherkhani and Afroozi, 2018)

Previous study shows that by adding fibres in stone mastic asphalt, it could enhance their mechanical properties like providing better aggregates contact and reducing binder drain-down. Fiber are mainly used in stone matrix asphalt and gap graded mixtures to prevent the draining out of binder during mixing and compaction (Mohammed, Parry and Grenfell, 2018). In his research paper ' Sound absorption performance of natural kenaf fibers,' Lim et al also states that it has good sound absorption performance in both normal and random sound absorption incidence. This shows that it could also reduce noise in the pavement by adding Kenaf fiber in stone mastic asphalt. SMA texture features good riding quality, improved skid resistance and relatively low noise (Irfan et al., 2019).

1.2 Problem Statement

According to Public Work Department (PWD) weather is one of the main cause for deteriorating road conditions. Not only that, it has been revealed that the road constructed does not follow the specifications as the contractors hired are cutting down on materials and this led to more issues as the road are exposed to increasing traffic volume over the years. Although various approach has been done to increase the awareness on using quality materials in pavement construction, there are still some who refuse making the users of the road pay for the consequences. Instead of lasting for another five or ten years, the road crumbles faster and need regular maintenance.

A potential problem associated with SMA is drainage and bleeding. Bleeding is caused due to difficulty in obtaining the required compaction. Therefore stabilizing additives such as cellulose fibres, mineral fibres or polymers are used to stiffen the matrix thereby reducing the drain down and bleeding significantly (Xavier *et al.*, 2018). Not only that, some of the road designed cannot occupy the heavy traffic load from heavy trailers making the road susceptible to potholes too. Hence, the aim of this study is to enhance the performance of stone mastic asphalt (SMA) utilising Kenaf fibre as an additive.

1.3 Objectives

The aim of the study is to enhance the performance of stone mastic asphalt in terms of cantabro loss, stability, stiffness, density, resilient modulus and dynamic creep with the existence of Kenaf fibre

1) To determine the material properties of penetration grade 60/70 type of asphalt binder and aggregate.

2) To evaluate the mechanical performance stone mastic asphalt by adding Kenaf fibre as an additive.

3) To determine the optimum fibre content (OFC) by ranking table method.

1.4 Significance of Study

Recently, due to the increase of environmental awareness, concern of environmental sustainability, growing global waste problem, initiation of ecological regulations as well as regulations, decrease of fossil fuels, increase of crude oil price have created interest to renewable resources like Kenaf.(Izran *et al.*, 2014). Kenaf fibre has proven to enhance asphalt mechanical properties when used as an additive in previous studies.

Enhancement in SMA could be seen in reducing its drain down properties. The fibers are helpful in improving the stone to stone contact between the aggregates and thus strengthening their bond. Natural fibres have gained attraction since they are extremely affordable, locally available and eco-friendly in contrast to conventional petroleum based synthetic fibres (EsmaeilpourShirvani *et al.*, 2019).

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